IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Applicants:	Zhixin Li
Title:	MAGNETIC FLUIDIC SEAL WITH IMPROVED PRESSURE CAPACITY
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Art Unit:	3676
Examiner:	Pickard, Alison K.

Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

DECLARATION OF DR. ZHIXIN LI

I, Dr. Zhixin Li, hereby declare the following:

1. I am the Vice-President of Engineering for Ferrotec (USA) Corporation.

2. I received a Ph.D. degree in Mechanical Engineering from the Massachusetts Institute of Technology.

3. I am the inventor or a co-inventor on three issued patents relating to ferrofluidic seals.

4. I have worked in the field of ferrofluid seals (exclusion, vacuum and high pressure) for over eighteen (18) years.

5. Exclusion seals and vacuum or high pressure seals are categorically different products and are based on different principles since exclusion seals are not designed to sustain a pressure difference on either side of the seal but to keep contamination out (i.e. exclusion), have different performance requirements and are for different applications.

6. Exclusion seals typically have a pressure capacity of 3 to 5 inches of water while vacuum seals typically have a pressure capacity of higher than 1,000 inches of water. High pressure seals have an even higher pressure capacity than vacuum seals.

7. By way of example, this difference can be compared to a toddler's tricycle with a speed of 2-3 km/hr to an Indy-500 race car with a speed of 400-500 km/hr, i.e.

about 200 times the tricycle.

8. Even though both the toddler's tricycle and the Indy-500 race car have wheels, they are based on different technical principles and require different engineering standards.

9. It would be difficult for one of ordinary skill in designing toddler's tricycles to design a high performance Indy-500 race car.

10. I have reviewed the cited reference EP 0 182 656 (EP 656) issued to Ferrofluidics Corporation and am familiar with its teachings.

11. EP 656 discloses an exclusion seal invention with a single tapered tooth on each side of a magnet, typically a rubber magnet.

12. The magnetic field used in exclusion seals is weak.

13. Because the magnetic field in the exclusion seal is weak, magnetic flux choking caused by the use of teeth on a pole piece is not a factor and the square tooth will have the same performance as a tapered tooth.

14. In vacuum seals, the magnetic field is much stronger, typically a high energy, rare-earth magnet is used.

15. Because the magnetic field is much stronger in vacuum seals, magnetic flux choking in the teeth area is the control factor for increasing pressure capacity.

16. A square tooth will intensify the magnetic flux choking causing a reduction in pressure capacity.

17. Magnetic field leakage is another phenomenon that is another control factor for increasing pressure capacity in vacuum seals, but is not a factor for exclusion seals because of the lower pressure capacity requirements and the use of a weaker magnetic field.

18. Understanding this phenomenon as it applies to vacuum seals requires expertise in magnetic theory and the help of a sophisticated analysis tool such as the Magneto Boundary Element Analysis software made by IES, Inc. of Winnipeg, Canada as well as specialized training to understand and utilize such a sophisticated analysis

tool.

19. I discovered that a tapered tooth will relieve magnetic flux choking and that the use of a double tapered teeth design will minimize the magnetic field leakage phenomenon, which was unexpected from the knowledge possessed by one of ordinary skill in the art of vacuum and high pressure seals regarding the use of square teeth.

20. One of ordinary skill in the art of exclusion seals would be unable to use the knowledge gained from EP 656 to invent the seal described in the present invention.

21. One of ordinary skill in the art of exclusion seals would not expect that the use of a tapered tooth seal would improve the pressure capacity of the exclusion seal because magnetic choking and magnetic field leakage are not controlling factors to improvements in exclusion seal design.

22. Even though EP 656 illustrates a tapered tooth shape, exclusion seals are based on different principles and for different purposes.

23. In order for one of ordinary skill in the art to be motivated to combine the tapered tooth shape with the double square tooth shape cited in U.S. Pat. No. 5,560,620, one of ordinary skill in the art would need to master the following: (1) understand exclusion seal design principles; (2) understand vacuum/high pressure seal design principles; (3) know magnetic circuit theory; (4) know how to generate a strong magnetic field; (5) know how to create and relieve a magnetic choking situation; (6) know how to use a sophisticated analysis tool such as Magneto; (7) know magnetic leakage and its effect on pressure capacity; (8) know magnetic focusing; and (9) know the effect of mechanical design to magnetic phenomena.

24. It is clear that one of ordinary skill in the art would not possess the knowledge required or the motivation to use the teachings of EP 656 and the teachings of the '620 patent to make the present invention.

Declarant further states that all statements made herein of his own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under

Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: 06/04/05 Name: Zhixin Li, Ph.D.